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Memorandum

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DATE: April 30, 1979

TO : San Luis Conveyance Channel Work Group

FROM : Aquatic Systems Analyst, CIFSG

SUBJECT: Synopses and Results of Modeling Runs Made April 24 and 25, 1979

I am sending each member of the work group a copy of a summary report of the trials we conducted in Fort Collins on April 24 and 25, 1979. I have attempted to summarize briefly the conditions as established for each run, including a scale drawing of the channel configuration pertinent to each trial. I have also included a summary table of available habitat for each trial, and a bar graph showing the potential habitat for all species and all ten trials. You may wish to color code each trial to better distinguish them on the bar chart. I was going to do that, but we can't xerox colors, and the bars are a bit small for zipatone.

I have not made any recommendations about which alternative is best, although I do have some ideas about that. The reasons that I haven't made those recommendations are: 1) I don't think it's my place to make a unilateral decision like that, and 2) I don't feel we've fully investigated all the possibilities. As I stated at the meeting, I would be willing to run a couple more options through if anybody has a new option he wishes to try. However, we are pretty busy with other clients, so your turn-around time would not be real fast. We would prefer to train someone involved with this in the operation of IFG software so that we would be relieved of these duties.

Some of you may have some difficulty in explaining the incremental method to your superiors, so I'm including a copy of a paper presented by Dr. Stalnaker at an International Symposium on Regulated Streams, as well as a brochure on the method.

I have enjoyed working with you on this problem. If the Instream Flow Group can be of further assistance with this, or any other problem, please let us know.

Ken Bovee, Hydrologist

Ken

Application of the IFG Incremental Method to Assess Fisheries Habitat Potential in the Proposed San Luis Conveyance Channel: Report of Results.

Objective: The objective of this study was to determine one or more design alternatives to the proposed San Luis Conveyance Channel which would 1) meet the conveyance requirements specified by the Bureau of Reclamation, and 2) provide the physical habitat required for both trout and trout food organisms to establish a fishery in the channel. Within the constraints of hydraulic efficiency, construction and operational costs, optimization of the physical habitat was attempted.

Procedures: A modified version of the Bureau of Reclamation's Water Surface Profiles Program was used to simulate hydraulic conditions in the original design channel, and in subsequent modifications of the original channel. IFG's HABTAT model was used to assess the utility of different channel configurations and/or substrate mixtures within the various channels. Evaluations were conducted using criteria for brown trout, rainbow trout, a burrowing mayfly (Tricorythodes minuta), and a freshwater amphipod (Hyalella azteca).

A total of ten trials, or options, utilizing either the original design channel, or modifications of the original channel, in conjunction with different mixes of substrate (bottom types), were evaluated for their habitat potential. The first two trials evaluated trout habitat only. Subsequent trials included evaluations for the invertebrates as well. It was the consensus of the work group that there was little benefit in creating habitat for fish if a food base for the fish could not be established.

Brief synopses of the conditions and results of each trial are given below:

Trial 1 - original prismatic channel (figure 1) with uniform compacted clay (native material) as bottom substrate.
Manning's n = .0225 for all sections.
Available habitat at Q - 170 cfs (square feet per 1000 lineal feet):

Rainbow trout

Fry	Juveniles	Adults	Spawning	Incubation
15	0	0	0	0

Brown trout

Fry	Juveniles	Adults	Spawning	Incubation
1000	1200	4000	0	0

Trial 2 - Original prismatic channel, with 50/50 mix of cobble and gravel, lining entire channel width (figure 2). Manning's n = 0.030. This option caused a rise in the stage of approximately 0.9 feet, and a reduction in main channel velocity from 1.30 feet per second to 1.08 feet per second.

Available habitat at Q = 170 cfs (square feet per 1000 lineal feet).

Rainbow trout				
Fry	Juvenile	Adult	Spawning	Incubation
1700	2200	15000	2	4300

Brown trout				
Fry	Juvenile	Adult	Spawning	Incubation
4800	5900	15000	70	4300

Trial 3 - Original prismatic channel, with cobble lining over one-fourth of the reach length (longitudinal distribution unspecified). Equivalent to Figure 2 for one-fourth of the distance and Figure 1 for three-fourths of the distance.

Available habitat at Q = 170 cfs (square feet per 1000 lineal feet)

Rainbow trout				
Fry	Juvenile	Adult	Spawning	Incubation
178	250	3400	0	765

Brown trout				
Fry	Juvenile	Adult	Spawning	Incubation
1700	2400	7000	0	765

Tricorythodes minuta	120
Hyalella azteca	7900

Trial 4 - Original prismatic channel. Essentially the same as trial 3, except that the cobble fraction is split 50/50 cobble-gravel. Final disposition of substrate is 3/4 clay, 1/8 cobble, 1/8 gravel. Gravel and cobble are not mixed.

Available habitat at 170 cfs (square feet per 1000 lineal feet)

Rainbow trout				
Fry	Juvenile	Adult	Spawning	Incubation
430	550	3200	0	980

Brown trout				
Fry	Juvenile	Adult	Spawning	Incubation
1800	2200	7100	19	980

Tricorythodes minuta	122
H. azteca	7900

Trial 5 - Original prismatic channel, with complete lining of cobble substrate (figure 2 for all sections). This trial also resulted in a 0.9 feet rise in stage as in trial 2).

Available habitat at 170 cfs (square feet per 1000 lineal feet)

Rainbow trout				
Fry	Juvenile	Adult	Spawning	Incubation
770	1100	15700	0	3580

Brown trout				
Fry	Juvenile	Adult	Spawning	Incubation
4400	6400	14400	0	3580

T. minuta	210
H. azteca	0

Trial 6 - This trial was the first attempt at modifying the original design channel. The modification consisted of cutting berms or interset terraces into the sides of the prism, creating an area of slow, shallow water for young fish and invertebrates. The dimensions of the berms for this trial were: cut width = 12', depth of cut = 3.5 feet below existing top of prism (floor of cut 4' above floor of canal). Substrate for this trial consisted of 1/8 gravel, 1/8 cobble, 3/4 clay, distributed as in trial 4. Figure 3 illustrates the configuration for this trial. The extra conveyance area provided with this configuration lowered the stage approximately 0.2 feet compared to the original design. Manning's n = 0.023 for clay sections, 0.030 for lined sections.

Available habitat at 170 cfs (square feet per 1000 lineal feet):

Rainbow trout				
Fry	Juvenile	Adult	Spawning	Incubation
110	250	3400	0	1325

Brown trout				
Fry	Juvenile	Adult	Spawning	Incubation
3200	3700	5700	0	1325

T. minutua	1100
H. azteca	12400

Trial 7 - Pursuant to discussion with Bureau of Reclamation engineers and other work group participants, it was felt that a 12-foot terrace might present maintenance difficulties for the canal, as well as being difficult for fishermen to fish over. Trial 7 utilizes a similar design as trial 6, but the berms are only 3 feet wide, and cut 0.5 feet lower on the side of the trapezoid. In order to provide cover and a food base for the invertebrates, the berms were planted to watercress in the simulation. The

main channel was retained as a clay substrate throughout. Manning's n = 0.100 over the berm and n = 0.0225 in the main channel. It was assumed that the watercress would not be used as cover by the trout. This option retained the hydraulic properties for conveyance of the original design channel. The channel configuration is shown in Figure 4.

Available habitat at 170 cfs (square feet per 1000 lineal feet).

Rainbow trout				
Fry	Juveniles	Adults	Spawning	Incubation
4	0	0	0	0

Brown trout				
Fry	Juveniles	Adults	Spawning	Incubation
1600	1900	4200	0	0

T. minutus	100
H. azteca	11800

Trial 8 - This trial is identical to trial 7 with the following exception: The substrate in the main channel was changed to 1/8 cobble, 1/8 gravel, 3/4 clay. Only the bottom of the canal was lined. The side slopes remain as clay substrate. It was again assumed that the watercress would not be used as cover by the trout. Figure 5 shows the configuration of one-fourth of the reach length. The other 3/4 would be illustrated by Figure 4.

Available habitat at 170 cfs (square feet per 1000 lineal feet)

Rainbow trout				
Fry	Juvenile	Adult	Spawning	Incubation
77	412	4200	7	1750

Brown trout				
Fry	Juvenile	Adult	Spawning	Incubation
2300	2800	6300	8	1750

T. minutus	110
H. azteca	8900

Trial 9 - This trial is identical to trial 7 with this exception: The model was set up to show the assumption that trout of all life stages (except spawning) would use the watercress as a favored form of cover. The channel description from trial 7 applies to this trial (Figure 4)

Available habitat at 170 cfs (square feet per 1000 lineal feet)

Rainbow trout

Fry	Juvenile	Adult	Spawning	Incubation
270	22	190	0	0

Brown trout

Fry	Juvenile	Adult	Spawning	Incubation
5500	5600	5500	0	0

T. minutus 100

H. azteca 11800

Trial 10: This trial is identical to trial 8, under the assumption that trout will utilize the watercress as cover, as in trial 9. (Figure 5 applies).

Available habitat at 170 cfs (square feet per 1000 lineal feet)

Rainbow trout

Fry	Juvenile	Adult	Spawning	Incubation
280	150	3600	7	1750

Brown trout

Fry	Juvenile	Adult	Spawning	Incubation
5700	6000	7100	8	1750

T. minutus 110

H. azteca 8900

Comparisons of the ten trials for the various species and life stages are shown in Figure 6. To better delineate individual runs, one might wish to color code each trial. For reproduction purposes it was not possible for IFG to do this.

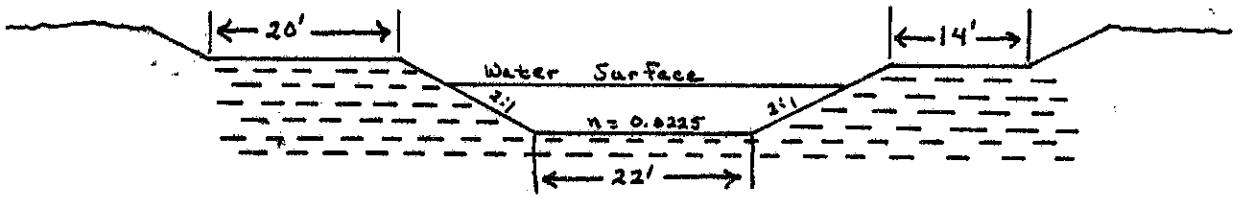

Figure 1: Original Design Channel, Compacted Earth (Clay) Substrate.

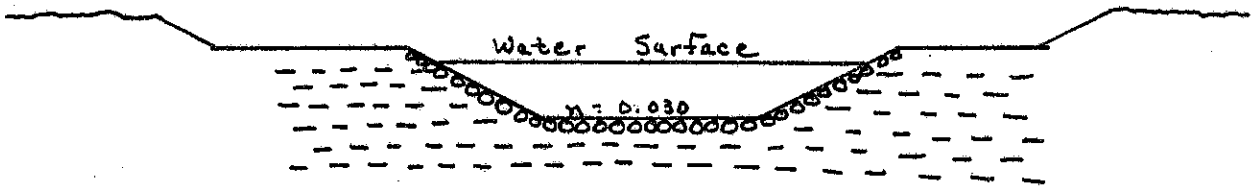

Figure 2: Original Design Channel, Compacted Earth Lined with Cobble (3"-12") or Gravel (½"-3") in Alternating Sections.

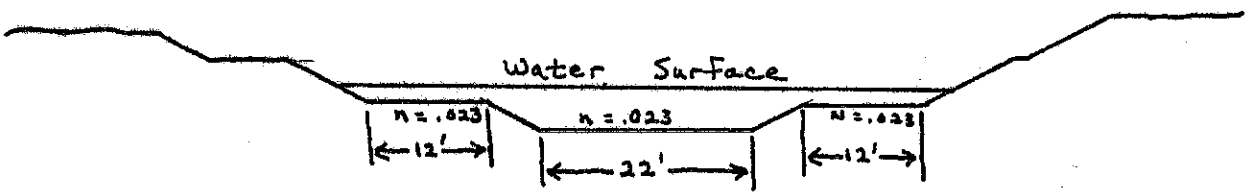

Figure 3: Design Alternative #1. Interset Terraces. Terraces unlined - basically compacted earth substrate, with no vegetation. Main channel, 1/8 gravel, 1/8 cobble, 3/4 clay as in Figure 2.

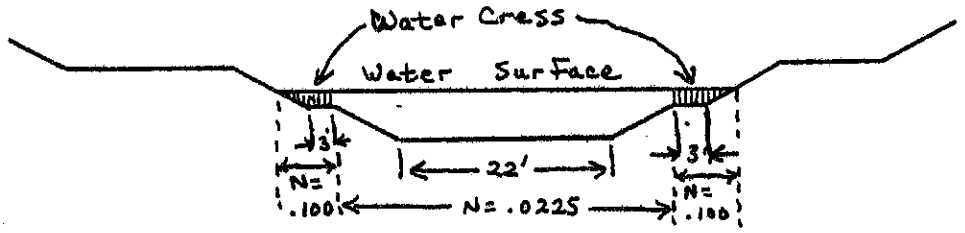

Figure 4: Design Alternative # 2. Interset terraces. Terraces unlined, but planted to watercress. Berm width equals 3 feet at base w/ 2:1 side slope; Berm height is 3.5 feet above canal base. Main channel unlined

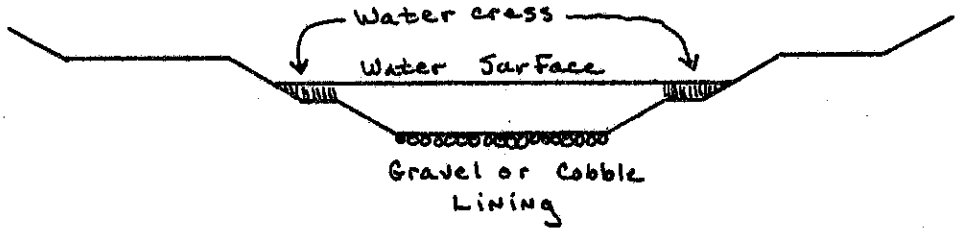

Figure 5: Design Alternative # 2. Interset terraces as in Figure 4. One-Fourth of the reach length lined with gravel or cobble (1/4 gravel, 1/4 cobble, 3/4 clay).

Figure 6: Comparison of the ten channel configuration trials for the four species evaluated by the incremental method.